CENTER ROUTING SLIP

FROM	DATE
C/TSSG	17 Mar

TO		INITIALS	DATE	REMARKS
DIRECTOR				1-2 FYI
DEP/DIRECTOR				
EXEC/DIRECTOR	2	[illegible]	3/16	
SPECIAL ASST	1	[illegible]	3/17	
ASST TO DIR				
HISTORIAN				
CH/PPBS	3			
DEP CH/PPBS				
EO/PPBS				
CH/IEG	4			
DEP CH/IEG				
EO/IEG				
CH/PSG	5			
DEP CH/PSG				
EO/PSG				
CH/TSSG	6			
DEP CH/TSSG				
EO/TSSG				
CH/SSD/TSSG				
PERSONNEL				
LOGISTICS				
TRAINING				
RECORDS MGT				
SECURITY				
FINANCE				
DIR/IAS/DDI				
CH/DIAXX-4				
CH/DIAAP-9				
CH/SPAD				

See my attached note. ff

File R&D:1

(1)

19 Mar 70

Comment --

I find this to be considerably less than reassuring or helpful in the economic judgments we must make.

Of course, we are not concerned about relatively small overruns (or those else where underruns). But when the actual cost -- as compared to estimated -- approaches 50% more than the estimated, we should know -- and find out why -- someone has erred in estimating. Also, when actual cost breaches double the estimated cost then we know that we erred in not renewing and renegotiating earlier.

The study must explain all

(2)

This stems directly from the following aspects -- most of the R&D efforts we engage in are for a definable purpose. Some can be defined more specifically than others, but in most cases we know or can imagine to some degree what we should like achieve. This means that we can put some measure of value on that purpose -- is it worth doing compared to what it will cost in time, effort and money? We may not put that judgment in writing or figures, but we make it in every case. Then, when the particular effort proves to be costing ½ to 2 to 3 times what we had roughly estimated, the ~~[redacted]~~ reason we went at it in the first place is no longer a valid reason.

25

OVERRUNS AND CHANGE OF SCOPE

IN R&D CONTRACTS

[redacted]

25

February 1970

Overruns and Change of Scope in R&D Contracts

Introduction

Overruns and changes of scope in R&D contracts tend to be regarded as "dirty words," and reflect upon the technical and administrative skills and general performance of Project Officers, Contracting Officers, and contractors. This paper will show that some of the characteristics of R&D work inherently give rise to overruns and changes of scope irrespective of the capabilities of the participants.

Overruns

Uncertainty is characteristic of most R&D work. If there were no uncertainty associated with the development of a particular piece of equipment, or in the implementation of a technique, there would be no need for R&D effort. The uncertainty in an R&D project tends to be greatest in those efforts which are basically exploratory in nature, since this work is oriented to determining whether certain design details are feasible of achievement. Programs which are concerned with the building of prototype equipment--especially equipment which may be suitable for operational use--tend to be less uncertain in fundamental areas and more concerned with equipment integration problems.

The uncertainty which is fundamental to R&D work is recognized in the formulation of the contracts--CPFF, EPIF, etc.--and certainly the "fair-game" expectation should be that half the contracts would overrun and half underrun.

For illustrative purposes, consider an R&D program for the development of a radar. The Project Officer and Contracting Officer develop the best estimate they can of the costs. They do this through an analysis of the proposals which may be submitted by several different companies, through comparison with similar development programs, and through the actual negotiation of the contract in which the final agreement with the contractor with respect to costs is stated. If this estimating process is performed in an ideal manner, the error, or the variation of the actual cost from the estimated cost, will sometimes be on the high side and equally likely on the low side. Theoretically, then, underruns and overruns should occur with equal frequency. Furthermore, the magnitude of overruns and underruns should balance.

Exploratory work with its greater degree of uncertainty should have a wider spread in terms of deviation from the estimated cost, but exploratory studies which produce only reports are anamalous in that the costs of these exploratory efforts are usually very close to the estimate. This occurs because of the way contracts for studies are usually written, i.e., that the contractor shall perform studies in certain areas to the extent limited by the cost, price, total man-hours, etc., stated in the contract.

In practice underruns turn out to be rather rare for a number of reasons. An informal agreement may be reached in which the contractor performs additional work to the limit of the estimated cost. This, of course, should theoretically constitute a change of scope. These kinds of informal arrangements and certain practices such as deliberately low bids in order to "buy in" are not considered here since the objective of this paper is to establish that overruns and changes of scope are inherent in R&D contracts even if all participants perform in a completely ethical manner.

Failure to make an allowance for inflation, increases in overhead rates, and similar factors also tend to shift the ultimate costs associated with an R&D project to the overrun side. It seems illogical to estimate R&D costs in which technical uncertainty is inherent to a high degree of precision, and fail to make a sensible allowance for inflation and other factors which may be relatively more predictable. Nevertheless, this is the practice, and it obviously contributes significantly to the bias toward overruns rather than underruns.

In summary, nearly all cost type R&D contracts should overrun or underrun. Making an appropriate allowance for other factors, if only few underruns occur cost estimates may be high; if there are many overruns the cost estimates may be low. The extent of percent deviation from the estimate should decrease as work moves from an exploratory to an engineering development phase, but in terms of dollars the deviation may increase since the total costs associated with final equipment

development are generally much larger than those associated with exploratory work.

Change of Scope

The actions that constitute change of scope are numerous and many are subtle. This discussion will treat only the effects of advances in the state-of-the-art of technology, i.e., changes of scope which are intended to improve the ultimate product of the contract through the incorporation of technical concepts or techniques which have become available after the initiation of the project.

The reason for developing a piece of equipment of a technique is usually to secure the advantages of certain improvements over existing equipment, or to develop something new. Both of these reasons reflect a judgment that the technical state-of-the-art promises improvement in performance which is worth the R&D and other costs necessary to obtain the equipment.

A trade-off which becomes critical as the program moves to prototype development is between the degree of obsolescence which the equipment will represent at the time it is available for operation versus the costs and delays which must be accepted in order to incorporate recent advances in technology. A competent and effective Project Officer can never "make up" his mind" but must continually evaluate potential improvements as they surface. Nevertheless, he becomes increasingly restricted as the development proceeds and incorporation of recent state-of-the-art advances becomes more difficult and costly.

Fortunately, good data exists to illustrate this situation.

5X1 Project [redacted] has been conducted for some time by the Department of Defense to identify the time at which critical items of technology which were essential to the performance of military equipment became available. These critical events which were considered basic to equipment performance included such things as the development of transistors, better fuels, etc. From an analysis of a number of different types of programs, if predecessor equipment existed, i.e., an existing radio set, radar, or other equipment which was to be replaced, only ten percent of the items critical to the performance of the new equipment were available prior to and incorporated into the development of the old equipment. Only ten percent of state-of-the-art technology in the old equipment was critical to the performance of the new equipment. Fifty seven percent of the critical technical items were developed in the period between the development of the old equipment and the initiation of final development of the new, and 33 percent of the items critical to the performance of the equipment ultimately produced became available after the development contract for the new equipment had been placed.

Obviously, in very simple cases a short development program may be conducted with no changes. However, in view of the trend to the development of more complex systems through which greater capabilities are achieved, changes of scope to achieve a better end product will be come more numerous. The programs

5X1 analyzed in Project [redacted] range from the development of

the Starlight Scope to provide night vision for infantry riflemen to rather simple computers, to the C-141 aircraft.

In summary, changes of scope will be required if new equipment is to be as effective as reasonably possible--and the decision as to what constitutes "reasonably possible" must reflect a continuing judgment on the part of all concerned with the development program.

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